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Plants with topical uses in the Ripollès district (Pyrenees, Catalonia, Iberian Peninsula): ethnobotanical survey and pharmacological validation in the literature

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Abstract

Ethnopharmacological relevance: The skin is the main structure that protects the human body from environmental factors and has, in addition, a relevant relationship to people's appearance and beauty. Official medicine and cosmetics have shown interest on elaborating products to protect the dermal system, yet the role of folk medicine is highly unknown in this field.

Aims of the study: Taking this into account, we performed an ethnobotanical study in a Catalan district of the eastern Pyrenees (northeast Iberian Peninsula), with the purpose of assessing popular plant knowledge and use. In this paper, we present exclusively the results on topically-used plants. Additionally, we have performed a thorough literature search in order to validate the uses of plants recorded in well-established pharmacological works.

Methodology: A number of 163 informants (57.7% women and 42.3% men, born between 1915 and 1988, with an average age of 71.6 years) were interviewed by means of 104 semi-structured interviews. Voucher specimens were collected, prepared and deposited in the BCN herbarium.

Results: We collected information on the popular uses implying topical application of 115 plant taxa (three determined at generic level and 112 at specific level), belonging to 92 genera and 51 families. Taxa with use reports higher than 5% included: *Arnica montana* subsp. *montana*, *Hypericum perforatum*, *Thymus vulgaris*, *Lilium candidum* and *Tussilago farfara*. The degree of reliability of the results is very high, as indicated by a big number of report uses (1676) and a very high informant consensus factor (0.93 of a maximum of 1). Topical uses of 21 plant taxa with more than 1% of use reports, have been validated consulting pharmacological literature.

Conclusions: Data indicate a high degree of plant knowledge in the studied region regarding dermal conditions, cosmetics and additional affections (such as snake bite). The present study constitutes a good basis for further phytochemical and pharmacological research, which could be of interest in the design of new drugs. Furthermore, the evidence of these folk uses could be the key information in simplified procedures established by the European Union for the registration of herbal medicinal products based on traditionally used plants, reinforcing the already recognised role of ethnobotany in the mentioned applied research and development field.

Key words: cosmetics; dermatological disorders; ethnobotany; ethnopharmacology; Pyrenees; topical use.

1. Introduction

Skin is the main structure that protects human body from the environmental factors and has, in addition, a relevant relationship to person aspect and beauty (Lall and Kishore, 2014). This is why applications for the skin are amongst the most important objectives of pharmaceutical industries, both with regard to dermatological pathologies as well as to cosmetics. At present, millions of people are affected annually with dermatological ailments (Tripathi and Srivastava, 2010), accounting for around 34% of all the disease cases recorded in the World (Abbasi et al., 2010). Skin problems can range from simple to major, including burns caused by contact with hot objects, fire or excessive exposure to sunlight as well as large infections caused by various pathogens, amongst others; even contact dermatitis caused by plants has a big incidence in rural areas (Modi et al., 2009). In addition, topical use of plants may also refer to the need for cleaning, moisturizing and taking care of the skin, as a barrier that protects the body from external aggressions. This interface between medicine and

cosmetics is undoubtedly of pharmacological interest, as it indicates the fact that the term cosmeceuticals was coined (Elsner and Maibach, 2000), in analogy to nutraceuticals, to denote this double focus of some remedies.

Every year, a great number of drugs are developed for the treatment of the skin, yet people are more and more in favour of developing drugs that ensure safety, efficacy and quality for patients and users (Shohania et al., 2002). Herbal remedies constitute a relevant part of the therapeutic arsenal used to fight against dermatological illnesses (Behl and Srivastava, 2002; Shenefelt, 2011). For this reason, research on ethnopharmacological use related to this subject can provide new approaches and novel solutions, giving to pharmaceutical companies supplementary knowledge about plants that can lead to innovative drugs, as well as benefiting local communities, able to share such knowledge, experiment with it, and promote its use. Traditional remedies, especially for minor illnesses, have gained importance and popularity in industrialized countries due, in part, to their perceived lower toxicity in front of synthetic compounds; during most part of the late 20th century, naturopathic medicine has become mainstream worldwide (Marini-Bettolo, 1980; Elvin-Lewis, 2001; Panthi and Singh, 2013). Many skin troubles are not severe, but some are serious, what is consistent with the idea that phytotherapy (either folk or industrial), as most so-called complementary and alternative medicines, mostly deals with mild or chronic affections, although they can also be useful in stronger cases (Barnes, 2003).

Cox (1994) reported that dermatological ailments are related to 15% of folk plant uses detected by ethnobotanical surveys, 11% of drugs in the US pharmacopoeia and 4% of western societies diseases treated with drugs derived from ethnobotanical information. Based on these data, this author predicted a success for ethnodirected bioprospection focused on such plant uses. This statement has been confirmed by rather abundant ethnopharmacological studies on plant topical use, which have been carried out, especially in African and Asian territories (Messele, 2004; Ajose, 2007; Abbasi et al., 2010; Martínez and Barboza, 2010; Jatav and Mehta, 2013; Kumar et al. 2013; Mabona et al. 2013; Panthi and Singh, 2013), but these kinds of studies are very scarce in Europe, especially outside Spain (Cavero et al., 2013; Pieroni et al., 2004, for works specifically targeting skin alterations; Camejo-Rodrigues et al., 2003; Akerreta et al. 2010; Calvo et al. 2011; Cavero et al. 2011a, b; González et al., 2010; Menendez-Baceta et al., 2014, for more general works containing some information on dermatological plant uses). These references often focus on a few species of plants (Tripathi and Srivastava, 2010), on pharmaceutical prospecting and validation (Cavero et al., 2013) or on the interactions between various plants (Al Aboud, 2011). Prior general ethnobotanical research in Catalonia

(northeastern Iberian Peninsula) has already shown the relevance of topical uses of plants (Agelet and Vallès, 2001, 2003; Bonet and Vallès, 2003; Rigat et al., 2007; Parada et al., 2009). The main aims of the present study were: i) to collect information about plant species used topically in the Ripollès district; ii) to analyse these ethnopharmacological data; iii) to look for coincidences of the reported uses in the literature in order to validate them from a pharmacological viewpoint (for species with more than 1% of use reports); and, iv) to propose new plant species for pharmacological validation of certain uses.

2. Material and methods

2.1 Study area

Ripollès is a Catalan district (*comarca* in Catalan language) located in the eastern Pyrenees, having a high mountain climate with Mediterranean influence (Fig. 1). The associated vegetation is characterized by alpine meadows occupying higher altitudes, followed, descending, by communities with *Pinus mugo* subsp. *uncinata* and *Abies alba* and forests with deciduous *Quercus* spp. and *Fagus sylvatica* as most predominant trees. Meadows, riverside woodlands, and crops constitute the remaining elements of the landscape (Vigo, 2008). Geographically, two different areas can be distinguished. The first one (Alt Ripollès), in the north, characterized by a high-mountainous area constituted by both Ter and Freser river valleys, and the second one (Baix Ripollès), in the south, is a middle-mountainous area constituted of a plane in the confluence of both aforementioned rivers.

Ripollès occupies an area of 956.6 km² and, in 2013, had a population of 25,995 inhabitants (IDESCAT, 2013) distributed in 19 municipalities, with a high percentage of the population inhabiting small villages and isolated houses. Agriculture is not a relevant source of income for most households—mostly due to climatic and orographic conditions— but many farms and houses have their own homegarden for private consumption. In the past, conventional medicine was difficult to access for these communities, promoting the use of plants or other natural resources as they were necessary to survive extreme conditions. Nowadays, official healthcare services reach virtually everybody in the region, but traditional practices seem to remain present, at least to certain extent.

2.2 Methodology

We used semi-structured interviews (Pujadas et al., 2004) as a technique for data collection from informants. Interviews were practiced from August 2004 to October 2013 after informing participants on the research purpose and receiving their consent. Native people,

mostly the elderly (over 70 years of age), were selected on a snowball basis (Goodman, 1961), and were interviewed in Catalan, common language both to interviewees and interviewers.

Information was obtained from 163 informants (born between 1915 and 1988 and an average age of 71.6 years; 57.7% women and 42.3% men) along 104 semi-structured ethnobotanical interviews (60 individual and 44 collective) covering the whole Ripollès area (all 19 municipalities). All interviews were recorded, transcribed and entered to a private database. All plants reported by the informants were collected and identified according to *Flora dels Països Catalans* (Bolòs et al., 2005). For botanical families, APG groupings were used (APG III, 2009). A voucher for each taxon was deposited at the *Centre de Documentació de Biodiversitat Vegetal*, University of Barcelona, herbarium (BCN).

Scientific name, vernacular name/s, botanical family, number of herbarium voucher, part of plant used, popular uses, pharmaceutical form and number of reports were recorded for each taxon. Some plant mixtures and preparation modes were also described.

In the present study, we included all plants with topical application independently if they were used for topical ailments, or related to other conditions. Hence, in addition to considering plants with dermatological uses (e.g. vulnerary or antieczchymotic), we also embraced plants with topical application not strictly indicated for skin disorders (e.g., antiophidian or antiallopecic).

2.3 Quantitative ethnobotany, statistical analyses and pharmacological validation in the literature

Several ethnobotanical quantitative indices were calculated from the obtained dataset. The informant consensus factor (F_{IC} ; Trotter and Logan, 1986) was calculated as the quotient between the number of topical use reports (UR) minus the number of used taxa and the number of topical use reports minus one. This index is more reliable when closer to 1. The index of medicinal importance (MI), recently proposed by Carrió and Vallès (2012), was also calculated, dividing the total use reports for a specific use-category by the number of taxa possessing this use. Descriptive statistical analyses and graphics were carried out with Excel software (Microsoft Office 2003).

To confirm the reported specific uses by participants in the study, we additionally reviewed the literature to carry out a pharmacological validation on most reported plants, using monographs (sometimes linked to databases) from official sources (Blumenthal, 1998; WHO 1999, 2004, 2007, 2009, 2010; ESCOP 2003; EDQM, 2010; EMA, 2010), along with

encyclopaedic bibliography on phytotherapy (Blumenthal, 2003; Duke, 2003; Vanaclocha and Cañigüeral, 2003). Additionally, we tested the used claimed by our informants in a general database on useful plants (PFAF, Plants for a future, <http://www.pfaf.org>), which is not a strictly pharmacological source, but contains a large and detailed information on medicinal plant uses.

3. Results and discussion

The list of collected plant species and related information is shown in Table 1, and summarized in Figs. 2 and 3. Informants reported a total of 115 taxa (112 species and three additional taxa identified at generic level), with a total of 1676 reports for topical uses (average of 10.28 use reports per informant). The 112 species included eight subspecies and one variety. Comparing the results with previous research with the same focus in and outside Europe is illustrative. In a study with a similar approach in a central-eastern Italian area, Pieroni et al. (2004) recorded 135 cosmetic, cosmeceutical or skin-healing preparations based on 70 plant species. One work with the same focus performed, as the current one, in an Iberian region (Navarra, Spain) recorded 982 uses for 91 plant species (Cavero et al., 2013). A relatively high amount of taxa is shared by the present research and the Italian (44 coincidental taxa) and Spanish (21, but only one third of the plants are explicitly mentioned in this work) studies, accounting for a common natural and cultural Mediterranean substratum. Conversely, only two of the species here reported (the cultivated *Allium cepa* and *Linum usitatissimum*) are coincidental with the 90 recorded for skin healing purposes in Uttarahand, India (Sharma et al., 2014). Even if the coincidence at generic level is slightly higher (10), this example of comparison with a remote territory clearly shows the differences in floristic and cultural bases.

These 115 taxa belong to 92 genera (those most reported include *Lilium* and *Solanum* with only three taxa each), and 51 botanical families, the Asteraceae (13.04% of total taxa), Lamiaceae (9.57%) and Crassulaceae (4.35%) being the three most represented families in number of species, and the Asteraceae (22.37% of total UR), Lamiaceae (11.69%) and Hypericaceae (11.1%) being the three most cited families in number of use reports (Fig. 2).

3.1. Use reports

Nine taxa were mentioned above 2% of UR (Table 2), including: *Arnica montana* subsp. *montana* (228 use reports; 13.6% of total use reports), *Hypericum perforatum* (172 UR;

10.26%), *Thymus vulgaris* (130 UR; 7.76%), *Lilium candidum* (110 UR; 6.56%), *Tussilago farfara* (98 UR; 5.85%), *Sambucus nigra* (63 UR; 3.76%), *Verbena officinalis* (41 UR; 2.45%), *Petroselinum crispum* (35 UR; 2.09%) and *Medicago sativa* subsp. *sativa* (34 UR; 2.03%). Within these species, which accounted for 54.36% of total use reports, *Arnica montana* subsp. *montana*, *Hypericum perforatum*, *Verbena officinalis*, *Petroselinum crispum* and *Medicago sativa* subsp. *sativa* were for the most part used as antiechymotic and mostly administered in lotion, liniment, poultice, multiple forms and poultice respectively; *Thymus vulgaris* was for the most part used as an external antiseptic almost exclusively in bath form; and *Lilium candidum* was mostly used as a vulnerary in lotion form. *Tussilago farfara* was used equally as a vulnerary and cicatrizing and always directly applied, and *Sambucus nigra* was employed for a great variety of topical conditions, as an external antiseptic being the most reported, and for the most part administered by fumigation. Certain specific uses of some plants are quoted by a very large number of informants. The one placed in the first position is the antiechymotic use of *Arnica montana* (204 reports) and *Hypericum perforatum* (153 reports). Those two taxa are components of several phytomedicines used for the purpose mentioned; this confirms the consistency between folk knowledge and possible industrial applications. Apart from other antiechymotic plants *Medicago sativa* and *Verbena officinalis*, 27 and 34 reports, respectively), other uses with a high number of reports are vulnerary (*Lilium candidum*, 53 reports), antiophidian (*Eryngium bourgatii* and *E. campestre*, 12 and 21 reports, respectively; these two species are in some cases used indistinctly by the informants), and external antiseptic (*Prunella grandiflora*, *Sambucus nigra* and *Thymus vulgaris*, 25 and 15 and 114 reports, respectively). These high amounts of quotations of some uses should be used as a complement to the reliability criteria that are addressed below in order to detect candidate plants to further pharmacological studies.

Plants claimed to be used as antiophidian are abundant (11 taxa) and have, overall, a high number of reports (64). It is worth mentioning that eight out of these 11 taxa are not recorded in the classical work on plants used against snake bite by Houghton and Osibogun (1993), including a list of ca. 900 taxa. These species are *Conium maculatum*, *Crataegus monogyna*, *Cucurbita pepo*, *Dracunculus vulgaris*, *Eryngium bourgatii*, *E. campestre*, and *Olea europaea*; at generic level, only *Eryngium* (with *E. foetidum* L.) is included in the mentioned compilation. In previous papers on Iberian ethnobotany (Agelet and Vallès, 2003; Camejo-Rodrigues et al., 2003) we have added novelties to this list, not comprising any of the taxa here reported now. Therefore, the present work contributes new possibilities for experimental tests

aiming to develop antivenins to fight against an important source of mortal accidents (Houghton and Osibogun, 1993).

A particular case is constituted by *Ranunculus parnassifolius*, whose aerial parts received 15 reports as antineoplastic for skin cancer, applied in various forms, especially embrocation. This taxon is claimed to be used against “mals dolents” (textually ‘bad illnesses’, an expression commonly used in Catalan language to refer to cancer without mentioning this name), particularly in this case against skin troubles. No pharmacological validation was found for this use in the literature, as *R. parnassifolius* corresponds to a species not included in any of the official sources consulted. No references of this use were found doing a broader literature search. Further laboratory or clinical study of the potentialities of this reported activity, would be of interest to validate any antitumor properties of the aerial parts of this plant species. Additionally, the use of this taxon could generate a conservation issue. Several informants reported that that in some occasions big amounts of the plant (full big bags) were collected. Furthermore, they stated that they have the impression that the populations of this Pyrenean endemic species are decreasing. This could be partly due to massive collections for medicinal purposes, but at least also partly to the diminution of the snow presence in the high mountain areas occupied by this taxon. Sáez et al. (2010) include this plant in the red book of endemic and endangered Catalan vascular flora, with the status of least concern. Population biology research would be suitable to confirm or not an impoverishment of the populations of this taxon, and to regulate its collection if necessary.

3.2 Parts of plants used and pharmaceutical forms

According to informants, different plants parts were used to prepare remedies with a topical application (Fig. 2). Most reported parts consisted of flowering aerial parts (22.37%), aerial parts (15.93%), inflorescences (14.98%), leaves (13.19%) and flowers (12.53%). These were the most cited, but there were parts such as thorns (*Crataegus monogyna*), resin (*Abies alba* and *Pinus sylvestris*), tubers (*Solanum tuberosum*) or sap (*Betula pendula*) with only two or three use reports (less than 0.2% of total UR). While the same plant can have various uses and distinct pharmaceutical forms, the part of the plant employed did not vary, in most cases, amongst informants. Only in a few cases, two or up to three different plant parts were used.

We found a wide range of pharmaceutical forms (up to 15) while the form of administration was always external (topical). Regarding pharmaceutical form (Fig. 2), the most reported was bathing the affected area, normally with a decoction of the plant (18.74%),

followed by liniments (16.83%), direct application (16.59%), lotions (13.19%), poultices (9.61%) and embrocations (9.55%). Nine additional forms, accounted for the remaining 15.51%.

In total, 30 uses were reported (Fig. 3). Amongst these, to treat ecchymosis was the most reported (30.85%), followed by far by external antiseptic (17.24%), vulnerary (15.87%), resolvent (5.19%), cicatrizing (4%) and antipyrotic (4%). Other uses, including antiophidian (3.82%), antiverrucose (2.86%), antitoxic (2.8%), and 21 more uses (13.37%) complemented the list. Results also indicated that one plant species could be used for different purposes or in different preparation ways, alone or combined with other plant species, varying from species to species.

3.3 Plant mixtures

As pointed out by participants, several species have been traditionally used in combination with other plant species to treat topical conditions (Table 3), enhancing the effects of remedies through synergy (Rigat et al. in prep.). Thirty-five mixtures made with combinations of a total pool of 60 plant taxa (i.e. more than half of the total reported) are given in Table 3. These include combinations from two to up to eight different species, and account for 4.41% of total UR. *Arnica montana* subsp. *montana* combined with *Hypericum perforatum* correspond to the most reported mixture (6 UR), followed by the combination of *Alkanna tinctoria*, *Salvia verbenaca*, *Sempervivum tectorum* and *Taxus baccata* (4 UR), along with *Arnica montana* subsp. *montana* combined with *Lilium candidum* (4 UR). In terms of individual species, *Hypericum perforatum* is the plant most reported amongst mixtures (17 UR in six combinations), followed equally with 14 use reports by three species: *Petroselinum crispum* (found in eight mixtures), *Ruta chalepensis* (in seven mixtures) and *Allium sativum* (in six mixtures). Next comes *Arnica montana* subsp. *montana* with 13 UR and present in three mixtures.

Within mixtures and similar to what happened for all plants, antiechymotic uses were the most significant (28.38% of total), followed by external antiseptic which represents 12.16% of total UR for mixtures. Nonetheless for pharmaceutical forms, different figures arose when compared to all plants recorded. For combinations of different plants, baths showed not being the most preferred form, while embrocations (16.22%) and poultices (16.22%) gained significance. Both, liniments and lotions remained significant. In our analysis of synergy, we ascertained the importance of vegetal oils and animal fats (either from chicken, usually an old hen, or from pig), that in the preparation of topical remedies act as a vehicle for active compounds.

3.4 Pharmacological validation from a literature survey

As reported by Cavero et al. (2013), topical use were validated for those 21 plants showing use reports higher than 1% (totalling over 70% of total use reports), using specialized literature on phytotherapy including monographs and general reference works (Blumenthal, 1998, 2003; WHO 1999, 2004, 2007, 2009, 2010; Duke, 2003; ESCOP 2003; Vanaclocha and Cañigüeral, 2003; EDQM, 2010). Not all plants were found in all literature sources used, indicating a lack of coverage in the literature. By far, Duke's CRC handbook of medicinal herbs (Duke, 2003) was the most inclusive, systematic and detailed work analysed, including all plants consulted.

Validation of ethnopharmacological uses in the literature (Table 2, fourth column) indicates that certain species, such as *Chelidonium majus*, *Hypericum perforatum*, *Thymus vulgaris*, *Arnica montana*, *Fraxinus excelsior*, *Verbena officinalis*, *Tilia platyphyllos*, *Petroselinum crispum*, *Allium sativum* and *Lilium candidum* have a high degree of validation in the literature, while *Eryngium campestre*, *Ranunculus parnassifolius*, *Prunella grandiflora* and *Conium maculatum* have no validation for any of their topical uses recorded in the Ripollès region. These four species do neither appear in the previous ethnopharmacological European works on plants used to treat skin diseases (Pieroni et al., 2004; Cavero et al., 2013). In between, the cases of *Cucurbita pepo*, *Tussilago farfara*, *Malva sylvestris*, *Vitis vinifera*, *Medicago sativa*, *Sambucus nigra* and *Olea europaea*, with certain relevant uses validated, while others lacking references in the literature. Amongst the latter species, experimental pharmacological validation of non-reported uses could be relevant in the search for new medicines and treatments with topical application, especially for those species showing high percentages of use reports (e.g., *Tussilago farfara* and *Sambucus nigra*).

Apart from the strict literature pharmacological validation, we tested the presence of the plant uses quoted by our informants in a general, large and comprehensive database on useful plants (PFAF, see methodology). Twenty three out of the 112 species reported in the present work have at least one use recorded in this database (Table 4), which contains information on around 1,500 plant species in 14 sections dealing with topical applications.

3.5 Use reliability

The overall data collected show a high consistency. On the one hand, 25 out of 30 uses have been quoted by three or more informants, representing 83.33% of all reported uses. This means that a great part of folk plant remedies in the studied area meets the reliability criterion

of Le Grand and Wondergem (1987) and Johns et al. (1990). On the other hand, the informant consensus factor (F_{IC}) is very high (0.93 of a maximum of 1, as defined by Trotter and Logan, 1986), indicating a high degree of agreement in the treatment of topical conditions in the area of study. This value is similar to the previous ones obtained in the upper river Ter valley for total medicinal uses (0.87; Rigat et al., 2007) and higher than the values for this factor found in Mallorca (0.71; Carrió and Vallès, 2012) and those reported from Mexican areas (0.75 and 0.79; Heinrich et al., 1998 and Leonti et al., 2001 respectively). In a neighbouring territory, Alt Empordà, the general consensus factor was very similar (0.91). Additionally, the obtained medicinal importance indices (MI, summarized in Fig. 3) for all the topical ailments are high. This shows a positive social perception of these uses and clearly accounts for a high consistency of the data recorded. The antieczymotic (MI=19.88), for punctures (MI=10.5) and cicatrizing (MI=9.57) show the highest values for this index.

Overall, these high consensus results, which suggest high reliability of uses claimed by the informants, encourage deeper pharmacological studies on this subject in the sampled area. For species with more than 1% of UR, topical uses validated in the literature also indicate a high reliability of data, except for a few taxa that would require further pharmacological research.

3.6 Perspectives in drug development

The plants used topically in the area prospected have shown themselves reliable in terms of consistency of their uses among population. Additionally, many of their applications are in agreement with data on relevant phytopharmacological literature. Either these plants or those with uses not reported in these sources could be considered in programs of drug development. First, as stated above, skin disorders and other troubles associated with topical uses are among the more frequent worldwide. Second, the European Union established a directive (2004/24/EC) on traditional herbal products establishing a simplified registration procedure for herbal medicinal products with evidence of use in the Community for at least 15 years. The present work (and others with similar approaches) can provide people dealing with drug design with the necessary evidences for this traditional use, reinforcing the already recognised role of ethnobotany in this applied field (Heinrich and Gibbons, 2001; Lewis, 2003).

4. Concluding remarks

The present study is the first one in the Catalan territories to focus on plants for topical use, and one of the very few within the European continent. The data collected show a high

degree of consistency and indicate a remarkable persistence of folk knowledge on plant uses for topical conditions, especially in a selection of plants. This is the first step in pharmaceutical bioprospection, which has contributed sufficient data of a reliable nature. These data may be the starting point for further research aimed at obtaining products that may generalise the alternative medical uses here considered at a local level. Phytochemical and pharmacological studies on some of the plants quoted here -of which we could provide material to potentially interested researchers- would be useful first steps in this process.

The amount and reliability of plant traditional uses shown in the present and many other ethnobotany-based papers, and the perspectives of such information in drug development make us believe that, if a past period of golden days of ethnopharmacology could be over, as stated by Gertsch (2009), a new similar age may perfectly occur nowadays, since, according to large and various current research evidence -to which this paper aims to contribute-, the challenges described by Heywood (2011) -in particular the cooperation with health sector- may most likely be addressed with success.

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Figure captions

Fig. 1. Map of the study area. a) Catalonia within Europe, b) Ripollès within Catalonia and, c) Ripollès district, with its municipalities (taken from www.municat.gencat.cat).

Fig. 2. Topical use reports according to: a) plant species; b) botanical family; c) plant part used, and; d) pharmaceutical form.

Fig. 3. Percentage of use reports with topical application. Percentages below 2% are not given a number and considered within the 'other' category. The indices of medicinal importance (MI, Carrió and Vallès, 2012: total use reports for a specific use-category divided by the number of taxa possessing this use) for the different activities are indicated within parentheses.

